



State-of-the-Art Reactor Consequence Analyses (SOARCA) Uncertainty Analyses

Background: What is SOARCA?

SOARCA was a major research project conducted by the NRC and its contractors to develop best estimates of the offsite radiological health consequences for severe reactor accidents at two plants, Peach Bottom and Surry.

What were the project's results?

Existing resources and procedures, when effectively implemented, can stop an accident, slow it down, or reduce its impact before it can affect public health.

Even if accidents proceed without effective intervention, they take much longer to happen and release much less radioactive material than earlier analyses suggested.

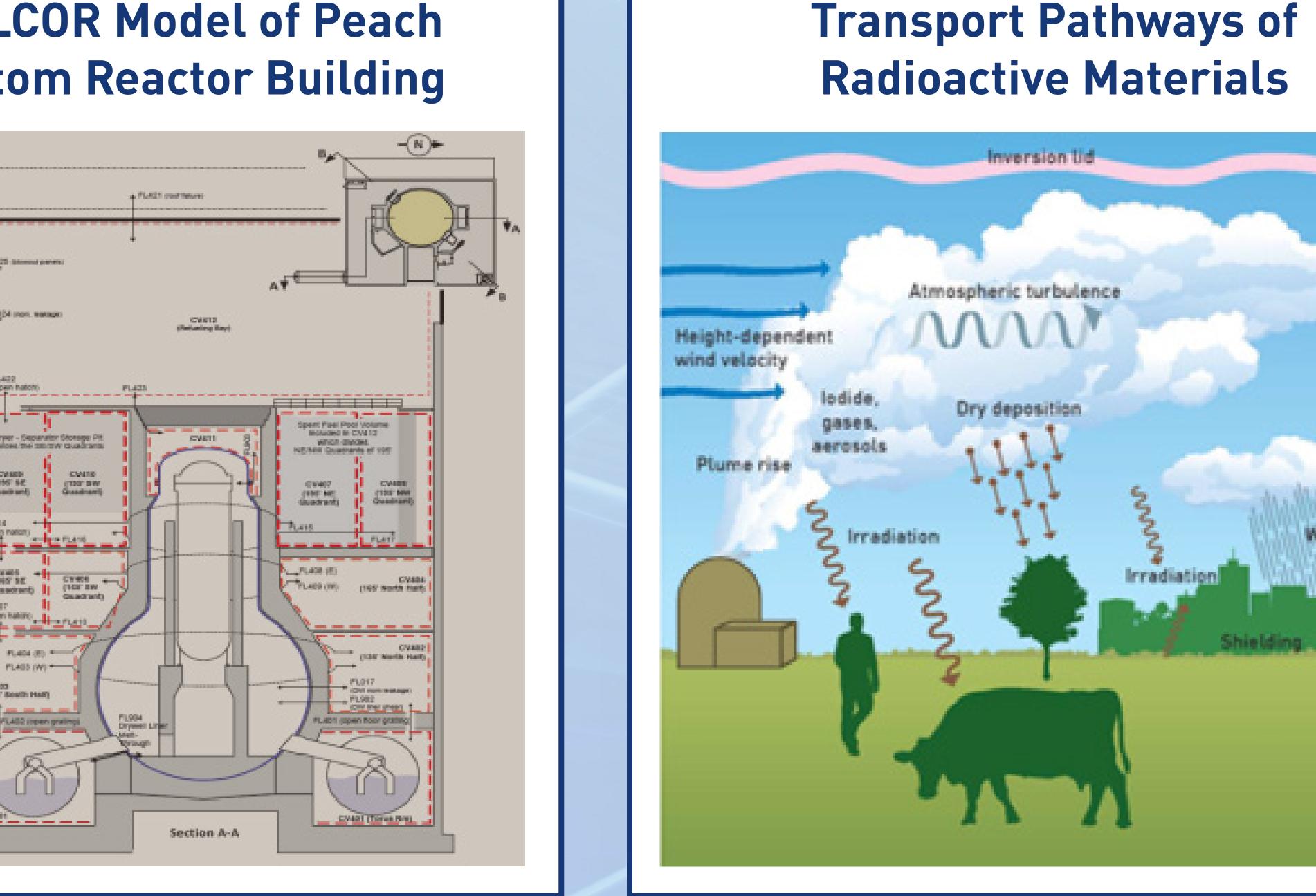
The analyzed accidents would cause essentially zero immediate deaths and only a very, very small increase in an individual's risk of a long-term cancer death relative to the average annual risk of cancer death for an individual in the United States from all causes.

Recent developments

The NRC is now overseeing a second uncertainty analysis for the short-term station blackout scenario at the SOARCA pressurized-water reactor pilot plant, Surry Power Station.

Distribution Distributions for Key **Uncertain Parameters** of Results - 0-10 miles Aleatory Mean Normal Sheltering Evacuation 0-20 miles Epistemic & Aleatory - Normal Piecewise Sheltering Piecewise - Evacuation Piecewise Combined Uncertainty in Groundshine Shielding Factors

model parameters. MELCOR Model of Peach **Bottom Reactor Building** L Clari -----PLACE (W) (165' North Hart)



Overview of SOARCA Peach Bottom Uncertainty Analysis

The NRC completed an integrated uncertainty analysis for the unmitigated long-term station blackout scenario at the SOARCA boiling-water reactor pilot plant, Peach Bottom Atomic Power Station.

The objective of this uncertainty analysis is to evaluate the robustness of the SOARCA project's deterministic results and conclusions, and to develop insight into the overall sensitivity of the SOARCA results to uncertainty in key modeling inputs. As this is a first-of-a-kind analysis in its integrated look at uncertainties in MELCOR accident progression and MACCS offsite consequence analyses, an additional objective is to demonstrate uncertainty analysis methodology that could be used in future combined Level 2/3 probabilistic risk assessment and consequence studies.

The analysis assigned distributions to uncertain MELCOR and MACCS input parameters and propagated uncertainty through Monte Carlo simulation. Four regression techniques were used to identify important model parameters.

The SOARCA project included aleatory uncertainty due to weather variability and reported the mean values of health consequence metrics. The uncertainty analysis added consideration of epistemic uncertainty due to key uncertain

yields an understanding of the relative importance of each uncertain input on potential consequence metrics.

Conclusions

The results of this uncertainty analysis corroborated the SOARCA project's conclusions of delayed releases compared to earlier studies, essentially zero risk of immediate deaths, and only a very, very small increase in an individual's risk of a long-term cancer death.

Assessing key MELCOR and MACCS parameter uncertainties in an integrated fashion

The results of the SOARCA Peach Bottom uncertainty analysis indicated that parameters describing safety relief valve behavior and the dry deposition velocity of contaminants are the most important uncertain model inputs for the chosen accident scenario.

This analysis confirms the known importance of some phenomena and reveals some new phenomenological insights.

The use of multiple regression techniques provides better explanatory power of which input parameters are most important to uncertainty in results.

MELCOR Uncertain Parameters

Sequence Issues

Battery duration

Safety relief valve (SRV) stochastic failure rate

In-Vessel Accident Progression

SRV thermal seizure criteria, and open area fraction

Main steam line (MSL) creep rupture open area fraction

Zircaloy melt breakout temperature

Molten clad drainage rate

Fuel failure criterion

Debris radial relocation time constants (solid and liquid)

Ex-vessel Accident Progression

Debris lateral relocation time constants (solid and liquid)

Containment & building behavior

Drywell liner failure flow area

Drywell head flange leakage parameters

Hydrogen ignition criteria (where flammable)

Railroad doors open fraction

Fission Product release, transport, and deposition

Cesium and iodine chemical forms

Aerosol deposition parameter

MACCS2 Uncertain Parameter Groups

Atmospheric Transport and Deposition

Wet deposition model linear coefficient

Dry deposition velocities

Dispersion parameters Emergency planning and response

Shielding factors

Hotspot and normal relocation

Evacuation delay and speed

Health Effects

Early health effects

Latent health effects

Groundshine dose coefficients

Dose and dose rate effectiveness factors

Inhalation dose coefficients

Cancer mortality risk coefficients

